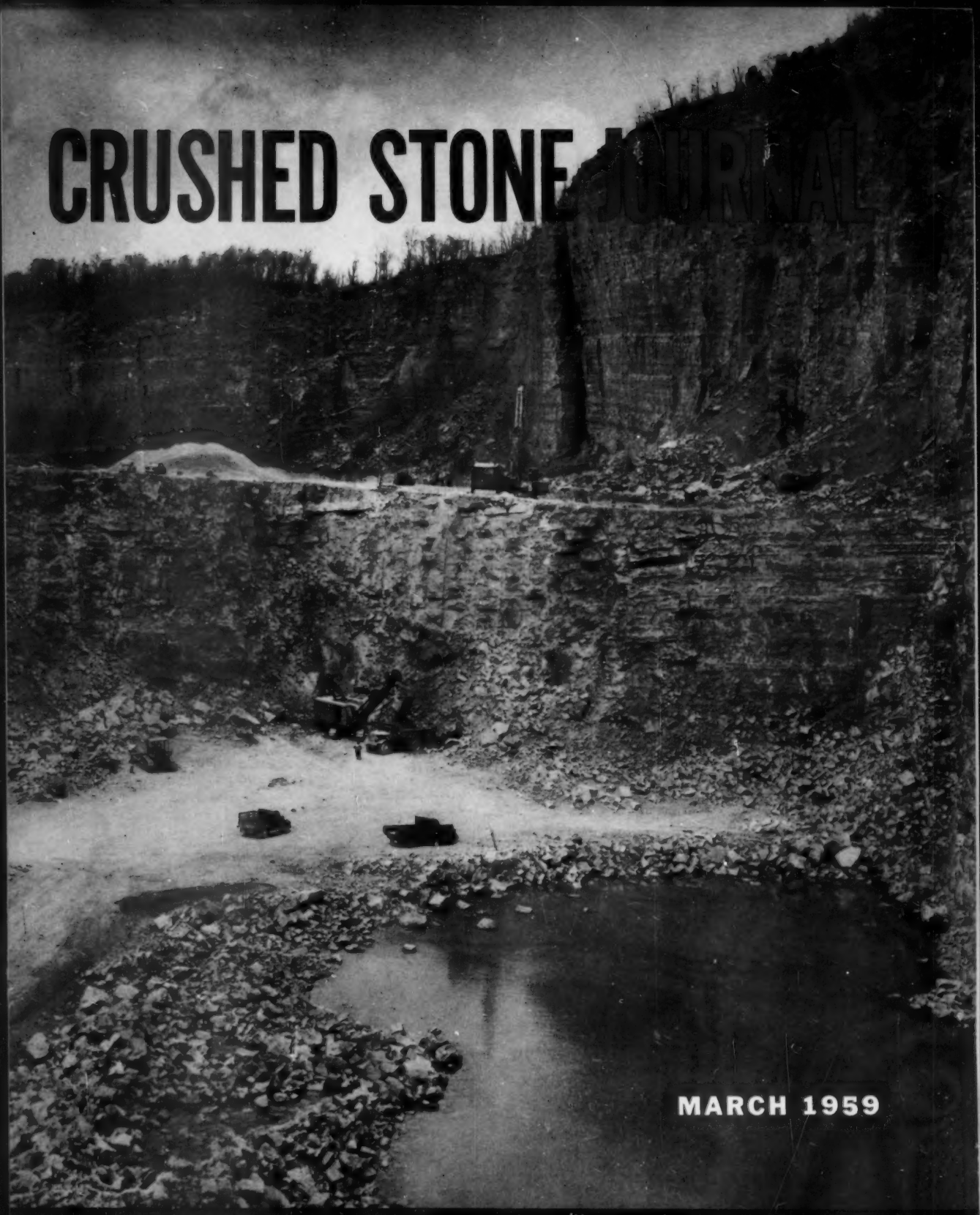
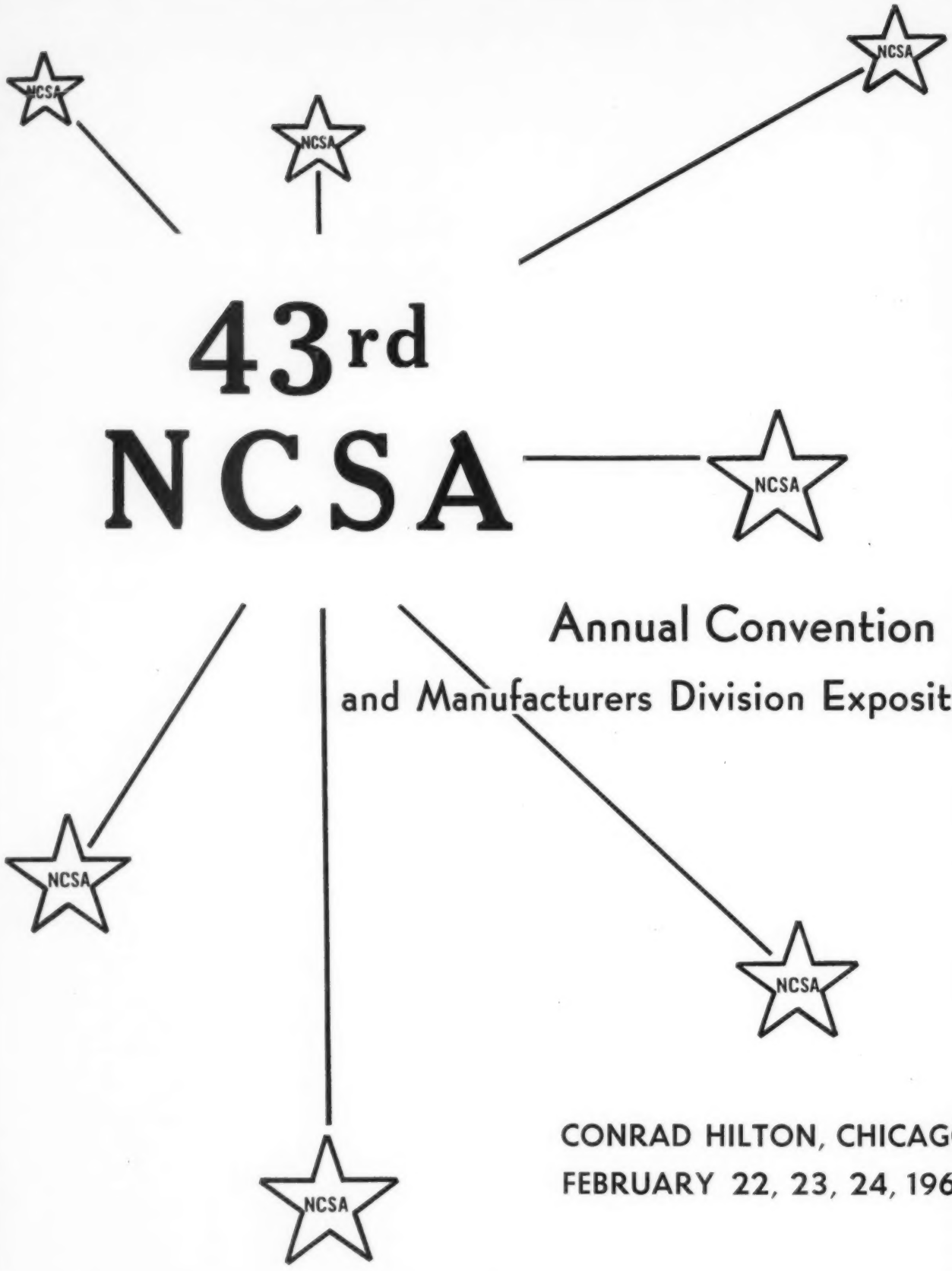
CRUSHED STONE JOURNAL



MARCH 1959



43rd NCSA

Annual Convention

and Manufacturers Division Exposition

CONRAD HILTON, CHICAGO

FEBRUARY 22, 23, 24, 1960

Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

Vol. XXXIV No. 1 PUBLISHED QUARTERLY March 1959

NATIONAL CRUSHED STONE ASSOCIATION

1415 Elliot Place, N. W.
Washington 7, D. C.

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G. D. LOTT, JR., Vice President
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J. R. BOYD

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Cover Photograph—Klotz Quarry of the Virginian Limestone Corp., Ripplemead, Virginia, D. L. Williams, President. Quarry face 285 feet high and 500 feet long.

W. C. ROWE

Treasurer
Rowe Contracting Company
Malden, Mass.

•

Elected President

NATIONAL CRUSHED STONE ASSOCIATION

by its Board of Directors
Miami Beach, Florida

January 26, 1959

W. E. COLLINS, JR.

Assistant General Manager
Explosives Department
Atlas Powder Company
Wilmington, Del.

•

Elected Chairman

MANUFACTURERS DIVISION

by its Board of Directors
Miami Beach, Florida

January 26, 1959

Over 1,000 Attend NCSA Annual Convention at Miami Beach, Florida

W. C. Rowe Elected NCSA President
W. E. Collins, Jr., Heads Manufacturers Division

THE attention of the entire crushed stone industry was focused on Miami Beach, Florida, during the 42nd Annual Convention of the National Crushed Stone Association, January 27 to January 30, 1959. Over 1,000 people from all parts of the country gathered together for what was unquestionably the finest Convention ever held by this Association. The record breaking attendance and the full to overflowing sessions and social functions are attributed largely to the unique and excellent program developed by the NSCA Convention Arrangements Committee under the capable chairmanship of Warren C. Rowe.

The importance of bringing members and guests together on an informal basis, to provide an opportunity for the free exchange of ideas and experiences, was not overlooked. Afternoons were open for individual plans and Convention social activities started with a get acquainted cocktail party Tuesday evening and were climaxed by a delightfully different Hawaiian Luau Thursday night.

At the sessions nationally known guest speakers and NCSA members presented unusually fine papers of great interest and lasting value on every aspect of quarry operations. In order for everyone to receive full benefit from as many of the subjects covered as possible, a few of the papers are reproduced in this issue of the JOURNAL, while others will be distributed in mimeographed or printed pamphlet form.

The two special Operating Sessions attracted the largest numbers ever assembled for any previous Convention session. The excellent papers on various aspects of quarry operations presented at Wednesday's session will soon be available in the 1959 Discussion of Operating Problems. The Operating Session on Thursday provided an

Thursday Night's Hawaiian Luau, January 29, 1959, Pool Patio, Americana, Miami Beach, Florida

W. C. Rowe
Rowe Contracting Co.
Malden, Mass.
President
National Crushed Stone Association

G. D. Lott, Jr.
Palmetto Quarries Co.
Columbia, S. C.
Vice President
National Crushed Stone Association

O. E. Benson
General Crushed Stone Co.
Easton, Pa.
Immediate Past President

N. E. Kelb
Cumberland Quarries, Inc.
Indianapolis, Ind.
Elected Past President

EXECUTIVE COMMITTEE

of the

NATIONAL CRUSHED STONE ASSOCIATION

for 1959

Clarence Camp, II
Camp Concrete
Rock Co.
Ocala, Fla.

Charles Coburn
Waukesha Lime &
Stone Co., Inc.
Waukesha, Wis.

W. P. Foss
New York Trap
Rock Corp.
West Nyack, N. Y.

R. S. Reigeluth
New Haven Trap
Rock Co.
New Haven, Conn.

Nelson Severinghaus
Consolidated
Quarries Corp.
Decatur, Ga.

D. L. Williams
Virginian
Limestone Corp.
Ripplemead, Va.

W. E. Collins, Jr.
Atlas Powder Co.
Wilmington, Del.
Chairman
Manufacturers Division

unparallelled opportunity for operating men and equipment manufacturers to talk over current practices and the many problems involved in the production of crushed stone. Some sixteen tables discussing eleven different subjects or phases of quarry operations filled the entire Grand Ballroom of the Americana. Those in attendance moved from table to table as their interest dictated to discuss their problems and seek solutions from operating men or manufacturers who had experienced and possibly overcome similar difficulties.

The action packed Convention program also featured special sessions for executives, salesmen, and finance officers and accountants. These sessions were extremely well attended and the many requests received for similar sessions at future Conventions were most gratifying.

W. C. Rowe Elected President of NCSA

The Board of Directors of the National Crushed Stone Association, elected by mail ballot prior to the Annual Convention, held its organizing meeting Monday afternoon, Januay 26, 1959. At this meeting, in accordance with the By-Laws, the Board elected the Officers and Executive Committee for the following year.

W. C. Rowe, Treasurer, Rowe Contracting Co., Malden, Massachusetts, was unanimously elected President of the National Crushed Stone Association. In accepting the honor, Mr. Rowe expressed his deep appreciation to the members of the Board of Directors for the confidence they had placed in him and pledged his efforts to further the purposes and aims of the Association in every way possible.

Other officers elected were as follows:

Vice President—

G. D. Lott, Jr.
Palmetto Quarries Co.
Columbia, S. C.

Treasurer—

J. R. Callanan
Callanan Road Improvement Co.
South Bethlehem, N. Y.

Secretary—

J. R. Boyd
National Crushed Stone Association
Washington, D. C.

Photographs of the 9 Regional Vice Presidents, elected by mail ballot prior to the Annual Convention, and the area each represents appear on page .

Election of Executive Committee

From the Past Presidents eligible to serve on the Executive Committee, N. E. Kelb of Cumberland Quarries, Inc., Indianapolis, Ind., was elected for the year 1959.

Organizing Meeting of Newly Elected NCSA Board of Directors

NEWLY ELECTED TO NCSA BOARD

G. H. Donaldson
Carbon Limestone Co.
Lowellville, Ohio

W. D. Milne
Kentucky Stone Co.
Louisville, Ky.

C. P. Palmer
National Lime
and Stone Co.
Findlay, Ohio

From the elected members of the Board of Directors eligible to serve on the Executive Committee, the following were unanimously elected for the year 1959: Clarence Camp, II, Camp Concrete Rock Co., Ocala, Fla.; Charles Coburn, Waukesha Lime and Stone Co., Inc., Waukesha, Wis.; W. P. Foss, New York Trap Rock Corp., West Nyack, N. Y.; R. S. Reigeluth, New Haven Trap Rock Co., New Haven, Conn.; Nelson Severinghaus, Consolidated Quarries Corp., Decatur, Ga; and D. L. Williams, Virginian Limestone Corp., Ripplemead, Va.

In addition to the elected members, the President, Vice President, Immediate Past President, and the Chairman of the Manufacturers Division serve as ex officio members of the Executive Committee.

The entire Executive Committee including elected and ex officio members is as follows:

NCSA Executive Committee

W. C. Rowe, *Chairman*

O. E. Benson	N. E. Kelb
Clarence Camp, II	G. D. Lott, Jr.
Charles Coburn	R. S. Reigeluth
W. E. Collins, Jr.	Nelson Severinghaus
W. P. Foss	D. L. Williams

Election of Honorary Board Members

W. N. Carter, Joliet, Ill., H. A. Clark, Chicago, Ill., S. P. Moore, Cedar Rapids, Iowa, H. E. Rodes, Nashville, Tenn., O. M. Stull, Buchanan, Va., Stirling Tomkins, West Nyack, N. Y., and Harold Williams, Brookline, Mass., were unanimously elected as Honorary Members of the Board of Directors.

W. E. Collins, Jr., Elected Chairman of NCSA Manufacturers Division

The Annual Luncheon and Business Meeting of the Manufacturers Division of the National Crushed Stone Association was held Thursday, January 29, 1959. At this Luncheon the results of the elections held during the organizing meeting of the Board of Directors of the Division on

Manufacturers Division Luncheon, January 29, 1959, Medallion Room, Americana, Miami Beach, Florida

Regional Vice Presidents for 1959
National Crushed Stone Association

A. N. FOLEY
New England
Connecticut, Maine,
Massachusetts,
New Hampshire,
Rhode Island,
Vermont

D. C. HARPER
Southwestern
Arizona, Arkansas,
Louisiana,
New Mexico,
Oklahoma, Texas

R. G. L. HARSTONE
British Commonwealth
Dominion of Canada,
United Kingdom,
Australia,
New Zealand,
Union of
South Africa

A. W. HEITMAN
Northern
Michigan,
Minnesota,
Montana, Nebraska,
North Dakota,
South Dakota,
Wisconsin

J. L. HOLDEN
Eastern
Delaware,
Maryland,
New Jersey
New York,
Pennsylvania,
District of Columbia

M. E. McLEAN
Midwestern
Illinois, Indiana,
Iowa, Kansas,
Missouri

A. W. McTHENIA
Central
Kentucky, Ohio,
Tennessee,
West Virginia

N. SEVERINGHAUS
Southeastern
Alabama, Florida,
Georgia,
Mississippi,
North Carolina,
South Carolina,
Virginia

B. G. WOOLPERT
Western
California,
Colorado, Idaho,
Nevada, Oregon,
Utah, Washington,
Wyoming,
Territory of Hawaii

Organizing Meeting of Newly Elected NCSA Manufacturers Division Board of Directors

Monday, January 26, 1959, were announced as follows:

Chairman—
W. E. Collins, Jr.
Atlas Powder Co.
Wilmington, Del.

Vice-Chairman—
George D. Fraunfelder
Easton Car Construction Co.
Easton, Pa.

Election of Executive Committee

From the Past Chairmen eligible to serve on the Executive Committee, Wayne W. King, W. S. Tyler Co., Cleveland, Ohio, was elected for the year 1959.

From the elected members of the Board of Directors eligible to serve on the Executive Committee, the following were unanimously elected for the year 1959: J. M. Hume, Pettibone Mulliken Corp., Chicago, Ill., and F. A. Pampel, Chain Belt Co., Milwaukee, Wis.

NEWLY ELECTED TO NCSA MANUFACTURERS DIVISION BOARD

GEORGE D. FRAUNFELDER
Easton Car & Construction Co.
Easton, Pa.

W. A. MCGRATH
Frog Switch & Mfg. Co.
Carlisle, Pa.

C. D. SMITH
Joy Manufacturing Co.
Pittsburgh, Pa.

In addition to the elected members of the Executive Committee, the Chairman, Vice Chairman, Immediate Past Chairman, and President of NCSA are ex officio members.

The entire Executive Committee including elected and ex officio members is as follows:

Manufacturers Division Executive Committee

W. E. COLLINS, JR., *Chairman*

L. A. Eiben	Wayne W. King
George D. Fraunfelder	F. A. Pampel
J. M. Hume	W. C. Rowe

Past Chairmen, Manufacturers Division

Clockwise: WAYNE W. KING, '56-'57; ABE GOLDBERG, '32-'33; B. R. MALONEY, '54-'55; J. C. MCLANAHAN, '50-'51; ROY WILLS, '29; J. H. FULKERSON, '41-'43; I. F. DEISTER, '52-'53

On behalf of the Manufacturers Division, L. A. Eiben, retiring Chairman, was presented with the traditional plaque in appreciation of his outstanding service to the Manufacturers Division of NCSA. The plaque is inscribed as follows:

For Distinguished Service
L. A. EIBEN
Chairman 1958
Manufacturers Division
National Crushed Stone Association

In accepting the plaque, Mr. Eiben expressed his gratitude for the helpful cooperation received during his term of office from the officers, committees, and members of both the Manufacturers Division and the National Crushed Stone Association.

NCSA Safety Contest Winners

One of the traditional features of the Greeting Luncheon is the impressive ceremony at which the well deserved awards are presented to winners

W. E. COLLINS, JR.
Atlas Powder Co.
Wilmington, Del.
Chairman
Manufacturers Division

GEORGE D. FRAUNFELDER
Easton Car & Constructon Co.
Easton, Pa.
Vice Chairman
Manufacturers Division

EXECUTIVE COMMITTEE

of the

MANUFACTURERS DIVISION

National Crushed Stone Association

for 1959

L. A. EIBEN
Northern Blower Co.
Cleveland, Ohio
Immediate Past
Chairman

WAYNE W. KING
W. S. Tyler Co.
Cleveland, Ohio
Elected Past
Chairman

J. M. HUME
Pettibone
Mulliken Corp.
Chicago, Ill.

F. A. PAMPEL
Chain Belt Co.
Milwaukee, Wis.

W. C. ROWE
Rowe Contracting Co.
Malden, Mass.
President
National Crushed
Stone Association

George White, Accepting the NCSA Safety Contest Award for Clinton Point Quarry, New York Trap Rock Corp., New Hamburg, N. Y., from H. H. Kirwin, Chairman of NCSA Accident Prevention Committee

of the NCSA Safety Contest. Winner of the top honors for the 1957 Contest was Clinton Point Quarry of the New York Trap Rock Corporation, West Nyack, N. Y. On hand to receive the handsome bronze plaque donated by the Explosives Engineer Magazine, was George White, Superintendent of the Clinton Point Quarry. In accepting this coveted award on behalf of the employees of the Clinton Point Quarry who had worked the impressive total of 374,800 injury free man hours in 1957, Mr. White expressed his appreciation to the U. S. Bureau of Mines, Explosives Engineer Magazine, and the National Crushed Stone Association, as well as to the other companies competing in the contest who, through their keen competition, provided added incentive.

Reproductions of the bronze plaque in the form of Certificates of Honorable Mention were presented to representatives of the other 44 perfect record plants which had participated in the 1957 Contest. In addition to this, individual employees of each of the winning plants were sent Certificates of Award by the National Crushed Stone Association in recognition of their part in building these impressive safety records.

A Table on Conveying and Screening at the Session for Operating Men and Equipment Manufacturers, Thursday Morning, January 29, 1959

1957 NCSA Safety Contest Winners

Top Row, *left to right:* R. L. WALKER for Cheektowaga Quarry, Mgr., Federal Crushed Stone Corp., Cheektowaga, N. Y.; JOHN JORGENSEN, Supt., Tomkins Cove Quarry, New York Trap Rock Corp., Tomkins Cove, N. Y.; GEORGE FOSTER, Supt., West Nyack Quarry, New York Trap Rock Corp., West Nyack, N. Y.; CHARLES BASS, Supt., Plainville Plant No. 4, New Haven Trap Rock Co., Plainville, Conn.; A. B. SCHMIDT, Supt., Metropolis No. 10 Quarry, Columbia Quarry Co., Metropolis, Ill.; G. B. PHILLIPS for Kimballton Mine, Kimballton, Va. and Pleasant Gap Mine, Pleasant Gap, Pa., Asst. Gen. Supt., Standard Lime & Cement Co.; HARRY WELLS, Representative elected by his fellow employees, for Kingston Plant No. 3, Callanan Road Improvement Co., Kingston, N. Y.; A. B. RADFORD, Supt., Bonne Terre Quarry, Valley Dolomite Corp., Bonne Terre, Mo.; W. H MCGEE, Gen. Plant Foreman, Pounding Mill Quarry, Pounding Mill, Va.; **Middle Row,** *left to right:* J. R. JOSEPH, Supt., Lima Quarry, for the following plants of National Lime & Stone Co.: Lima Quarry, Lima, Ohio, Buckland Quarry, Buckland, Ohio, Rimer Quarry, Rimer, Ohio, and East Liberty Quarry, East Liberty, Ohio; LEON LEWIS, Plant Supt., Cairo Quarry, Catskill Mountain Stone Corp., Cairo, N. Y.; H. D. PERRY for Knippa Plant No. 4, Vice Pres. Southwest Stone Co., Knippa, Texas; CHARLES DAYHUFF, Supt., Osgood Quarry, South Eastern Materials Corp., Osgood, Ind.; GEORGE WHITE, Supt., Clinton Point Quarry, New York Trap Rock Corp., New Hamburg, N. Y., *top winner* 1957 NCSA Safety Contest; H. H. KIRWIN, Treas., Eastern Rock Products, Inc., Utica, N. Y., *Chairman,* NCSA Accident Prevention Committee; EMIL BERRY for Avoca Quarry, President, Jefferson County Stone Co., Inc., Avoca, Ky.; ROBERT WRIGHT, Representative elected by his fellow employees for South Bethlehem Plant No. 1, South Bethlehem, N. Y.; D. R. KNOTT for Cypress Quarry, Pres., Charles Stone Co., Cypress, Ill.; **Bottom Row,** *left to right:* G. L. RANSIER, Supt., Sodus Quarry, General Crushed Stone Co., Sodus, N. Y.; J. P. CIVIAL, JR., Supt., Rock Hill Quarry, General Crushed Stone Co., Quakertown, Pa.; BURR SHAVER, Supt., White Haven Quarry, General Crushed Stone Co., White Haven, Pa.; W. J. CLARK, Vice Pres. and Plant Supt., Munnsville Quarry, Munnsville, N. Y.; HAROLD CESSFORD for Alden Quarry, Alden, Iowa, Big Horn Quarry, Warren, Mont., and Lowden Quarry, Lowden, Iowa, Vice Pres., Weaver Construction Co.; W. P. MILNE for Russellville Mine, Pres., Kentucky Stone Co., Russellville, Ky.

Hostesses for Ladies Entertainment

Left to Right: MRS. CLARENCE CAMP, II, MRS. NELSON SEVERINGHAUS, AND MRS. L. A. EIBEN

Ladies Activities

Three charming and gracious hostesses, Mrs. Clarence Camp, II, Mrs. Nelson Severinghaus, and Mrs. L. A. Eiben were on hand in the Ladies Social Headquarters to greet the well over 300 ladies in attendance. The ladies found much of interest and pleasure in their special program, which included the Cheerio Tea, morning coffee hours, a boat trip on Biscayne Bay, as well as plenty of free time for swimming and sunning, individual sightseeing trips, and shopping. In addition, the ladies thoroughly enjoyed the NCSA luncheons and social functions.

Hawaiian Luau Highlights Social Activities

The beautiful Pool Patio of the Americana provided the setting and atmosphere for Thursday night's Hawaiian Luau. Native Hawaiian girls welcomed well over 900 guests by placing colorful leis around their necks in the traditional Polynesian manner.

The wonderful dinner served from palm decorated huts surrounding the pool featured many rare and unusual Hawaiian dishes and was completely enjoyed by everyone.

To add to the enjoyment and in keeping with the Hawaiian theme, NCSA, through its Washington entertainment counsel, was able to obtain the services of Hilo Hattie and her Hawaiian Revue. This internationally known group royally entertained with romantic, gay, and humorous songs and dances of the Islands. The huge audience thrilled to the exciting knife dance performed by Chief Satini and was awed by the equally unusual and spectacular fire dance.

Lovely native girls danced the hula and sang captivating songs of the Islands in the expressive and traditional manner of a Hawaiian Luau.

As though on some prearranged signal, following the entertainment, a lovely moon cast its silvery path across the peaceful ocean at the very feet of guests as they happily danced to the strains of Hawaiian music and popular tunes of today.

It will be difficult indeed to match the practical and profitable yet wonderfully relaxing experience of the 42nd Annual Convention of the National Crushed Stone Association.

Cover Photographs for the Crushed Stone Journal

Since changing the cover of the **Crushed Stone Journal** in June 1958, we have received many requests to identify the quarries in our cover photographs. Starting with this issue you will find the cover photographs identified on the contents page.

Our June 1958 cover featured the Oriskany Falls quarry of Eastern Rock Products, Inc., Utica, N. Y.; the September 1958 cover was an aerial photograph of the quarry of the Granite Rock Co., Watsonville, Calif.; and the December 1958 cover was part of the quarry of Acme Limestone Co., Fort Spring, W. Va.

The Editor of the **Crushed Stone Journal** would be pleased to consider all photographs that meet the following requirements:

1. Photographs must be of an NCSA member's quarry
2. Photographs should feature the quarry face; or, if an aerial view, must be readily identifiable as a crushed stone quarry
3. Photographs must be clear and sharp with good light and dark contrast and of good composition
4. Photographs should be vertical shots or suitable for cropping.

All photographs should be sent to the National Crushed Stone Association, 1415 Elliot Place, N.W., Washington 7, D.C. If your photographs are not used they will be returned promptly.

W. F. Wise

1889-1959

In Memoriam

To his many friends in the National Crushed Stone Association news of the passing of W. F. Wise, or Bill, as he was affectionately known, will be received with sincere sorrow and a deep sense of loss.

Mr. Wise had not been in good health for the last several years and a fall at home which he suffered last August resulted in several broken ribs and an alarming increase in his blood pressure. With the indomitable spirit so characteristic of him, he then successfully weathered several strokes, seemed to be improving, when quite suddenly and unexpectedly the end came on January 19, 1959, at Dallas, Texas.

Following graduation from Texas A. and M., Mr. Wise began his civil engineering career in 1909 with the Southern Pacific Railway as Roadman. Through successive and rapid promotion he rose to Roadmaster at Houston in 1915. He then went to the Missouri, Kansas and Texas Railroad serving with increasing responsibilities until 1920.

Mr. Wise first became identified with the crushed stone industry in 1918 when he purchased the Stringtown Crushed Rock Company at Stringtown, Oklahoma. In 1925 he added to his holdings the Texas Trap Rock Company of Knippa, Texas. Following the acquisition of the Lone Star Stone Company at Chico and Bridgeport, Texas, in 1928, he consolidated all his holdings into the Southwest Stone Company of Dallas, Texas, which he served as President until shortly before his death when he became Chairman of the Board.

His organization joined the National Crushed Stone Association in 1923, and in 1926, Mr. Wise was elected to the Association's Board of Directors. Thus began his active and vigorous participation in Association affairs.

In 1929 and 1930, his fellow members accorded Mr. Wise the high honor of electing him to the Presidency of the National Crushed Stone Association, in which capacity he served faithfully and energetically. At the Association's Silver Anniversary Banquet, held in Cincinnati in 1942, the late Otho M. Graves, in paying tribute to those who had outstandingly contributed to the growth and development of the Association, said: "In January of 1929 at the Hollenden Hotel, in Cleveland, we turned to the southwest for a President and selected a man whose devoted loyalty to the interests of the Association had been outstanding. Of course you know that I am referring to Bill Wise. During his Presidency it was remarkable to us on the Board and on the Executive Committee how faithfully Bill would take the trips to and from Dallas, Texas, to Washington when occasion demanded, which was not infrequent. His trips were not limited to attendance at Board and Executive meetings. He went to Washington oftener than that because of his belief that he should maintain reasonably constant touch with the Washington staff and the work of the Laboratory, in which he was intensely interested."

During his long and active participation in Association affairs, Mr. Wise served in several capacities. From 1926 until the time of his death he was a member of the Board of Directors; he served on the Executive Committee from 1929 to 1931, inclusive, and again from 1944 to 1953, inclusive. For the years 1928, 1941, and 1944, he was Regional Vice President for the Southwestern Region.

Bill Wise was never adverse to expressing his opinion forthrightly and vigorously. Rugged individualism and tenacity of purpose were outstanding characteristics of his personality, and yet, he cooperatively accepted the will of the majority.

Bill Wise ably served NCSA during an important phase in its development and the imprint of his personality will not soon vanish from the pages of Association history. Deep in our hearts, we will miss you, Bill.

Mr. Wise is survived by his wife, Ruth, 5809 Desco Drive, Dallas, Texas; three sons, W. Foster Wise of Dallas, W. Denman Wise of San Antonio, Whitby J. Wise of Dallas; one daughter, Mrs. Wallace L. Richardson of Dallas; and four grandchildren.

Whitby J. Wise is the only member of the family connected with the Southwest Stone Company.

To Bill's family and business associates, we extend heartfelt sympathy in their bereavement.

Skid Proofing of Asphaltic Concrete Pavement Surfaces[1]

By J. E. GRAY
Engineering Director
National Crushed Stone Association
Washington, D. C.

and A. T. GOLDBECK
Engineering Consultant
National Crushed Stone Association
Washington, D. C.

Introduction

OVER 38,000 persons were killed on highways in the United States in 1957 and thousands more were seriously injured. In many of these accidents skidding was involved and in far too many the vehicles were moving at excessive speed. No doubt some of the pavement surfaces were too slippery; others, however, would have been safe had the speed of the vehicles been reduced to that dictated by prudence and common sense. Tires will slide even on the most skid resistant surface when the brakes are locked, but how far the vehicle will slide depends on its speed as well as on the slipperiness of the road surface, the brakes, tires, and other factors. Caution and the proper regulation of driving speed are required on wet pavements regardless of their surface composition.

Some pavement surfaces are exceedingly slippery when wet and steps should be taken to cure this condition immediately. But the degree of resistance to sliding or skidding that is necessary, either in a newly built pavement or later, after wear has taken place, is something to be considered carefully. One might conclude, without sufficient thought, that the most skid resistant surface possible should always be used but, on the other hand, the prevention of skidding is not only a technical matter which involves sufficient skid resistance, but also it involves economics which includes original cost, the durability of the surface, and its stability under traffic. The most skid resistant pavement may be the most expensive without being more effective than another surface adequate for the purpose.

Some Mechanics Involved

When a vehicle is moving it has kinetic energy and, when the brakes are applied, the force of friction between the tires and the road surface acts on the vehicle, thus bringing it to rest. The work done by this force of friction essentially equals the kinetic energy originally possessed by the vehicle. Referring to Figure 1, the above idea may be expressed as follows:

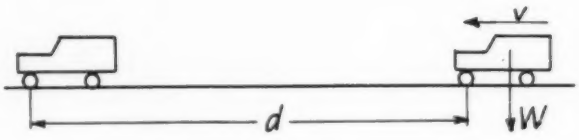

FIGURE 1
Stopping Distance Calculations

$$Fd = \frac{Wv^2}{2g} \qquad fd = \frac{v^2}{2g} \qquad d = \frac{v^2}{2fg} = \frac{V^2}{30f}$$

Where
F = force of friction
f = coefficient of friction
W = weight of vehicle
v = velocity of vehicle in ft per sec when brakes are applied
V = velocity of vehicle in mph
g = acceleration of gravity = 32.2 ft per sec per sec
d = stopping distance in ft

The coefficient of friction (f) decreases with increased speed, but the variation of friction with speed is not the same with different road surfaces. However, using Professor Moyer's California test results at different speeds on different surfaces, an estimate has been made of the approximate coefficient of friction at various speeds if the

[1] The present paper discusses the cure for slippery asphalt pavements but it is not intended to imply that slipperiness occurs only in this pavement type. The cure for slippery concrete pavements will be discussed in a subsequent issue of the Crushed Stone Journal

coefficient at 40 mph is 0.40. To calculate the stopping distance of a vehicle under impending crash conditions, the so-called reaction time of the driver must also be taken into account and this is 0.5 sec, more or less, depending on the driver. During that reaction time the vehicle travels a very considerable distance. Also, an interval of time elapses between the perception of a probable obstacle and the driver's decision to do something about it. This perception time varies from a small fraction of a sec up to 1 1/2 sec and thus, with some drivers, as much as 2 sec might elapse before the brakes are actually applied. Even at 30 mph this could mean that the car has traveled 88 ft.

The following Table I, although necessarily approximate because of the variable effects of different pavement and other conditions on the test results, still is sufficiently correct for illustrative purposes. The effect of perception time has been omitted; it is so variable.

TABLE I

Speed mph v	Coefficient of Friction f	Calculated Stopping Distance, $d = \frac{V^2}{30f}$ ft	Correction for Reaction Time ft	Total Stopping Distance ft	Ratio of Stopping Distances
30	0.44	68	22	90	1
40	0.40	133	29.8	163	1.8
50	0.39	213	36.6	250	2.8
60	0.38	315	44.0	359	4.0
80	0.38	560	58.5	619	6.9

The stopping distance at 60 mph, on a road having f = 0.40 at 40 mph, is 359 ft. On this same road, if the speed were reduced only 10 miles, down to 50 mph, the stopping distance would be reduced from 359 down to 250 ft, a difference of 109 ft. Now if this road were required to have a coefficient of friction of 0.6 at 40 mph (= 0.57 at 60 mph), the stopping distance would be $60^2/30 \times .57 + 44.0$ ft $= 210 + 44 = 254$ ft. Quite evidently, then, a reduction in speed from 60 to 50 mph is safer than raising the friction coeffi-

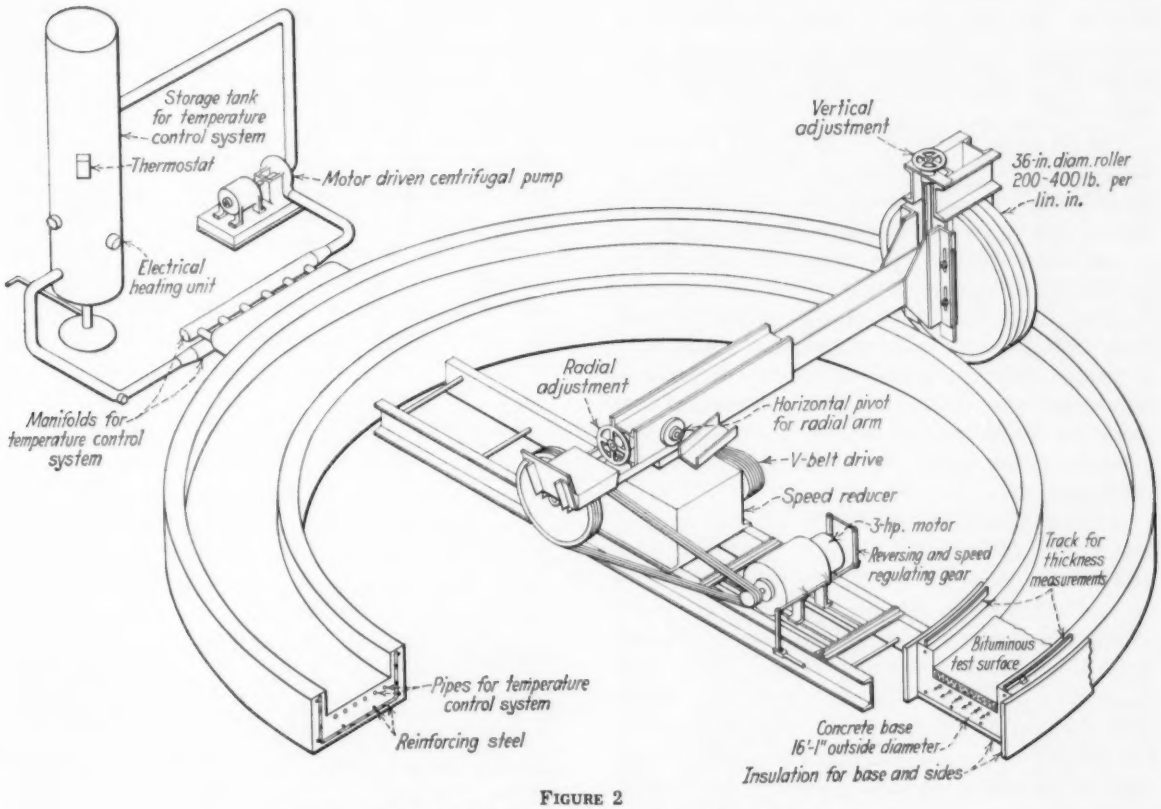

FIGURE 2
Circular Track for Preparing Pavement Sections for Skid Test

cient from 0.4 to 0.6, but maintaining a 60 mph speed. (254 ft as compared with 250 ft).

The folly of maintaining high speed during wet weather when the friction coefficient is low should be evident. On all but the obviously slippery pavements, a very moderate reduction in speed would prevent most skidding accidents.

The question naturally arises—What is an obviously slippery pavement and to what degree should a pavement surface be made skid resistant? This is a question to which the National Crushed Stone Association has devoted a lot of study and research over the past 6 years.

Method of Studying Slipperiness of Pavement Surfaces in NCSA Laboratory

Pavement surfaces are subjected to the abrasive action of tires and surface grit which tends to wear off the sharp, projecting points in the aggregate. The flexing of the tires creates a rubbing action in addition to that which takes place due to traction, braking, and steering. This action creates a surface polish which makes the pavement slippery. Wearing and polishing take place much more quickly with some aggregates than with others.

One of the requisites in preparing pavement surfaces to study skidding in the laboratory is to subject them, as nearly as possible, to the same kind of polishing action as they will get in actual pavement surfaces. In the NCSA Laboratory this is accomplished by the use of a circular track apparatus as shown in Figure 2. The track is 14 ft in mean diameter, built with a trough shaped section. The test sections of either asphaltic concrete or portland cement concrete are rolled or laid in this track. Up to 20 different sections may be laid and tested in the same test series.

Bituminous sections are first rolled with a heavy steel roller, followed, in place of the roller, with a 2000 lb weighted rubber tired truck wheel, until the surface texture is closed as in actual pavements. Then this pneumatic tired wheel is rolled around the track thousands of times, first with water and fine sand on the track and finally clean and dry so that the rubber tire alone exerts a polishing action on the surface. Initial rapid wear of the surface is sometimes, but not usually, accomplished by the aid of a rubber drag. The circular track action closely resembles that of traffic and hence the track is an ideal machine with which to prepare the specimens for skid tests.

NCSA Wheel Slipperiness Testing Machine

At the end of selected numbers of passages of the wheel, measurements of slipperiness are made. Since no satisfactory method for measuring slipperiness seemed to be available, the idea was conceived of using the device shown in Figure 3. Essentially, this consists of the front wheel of a

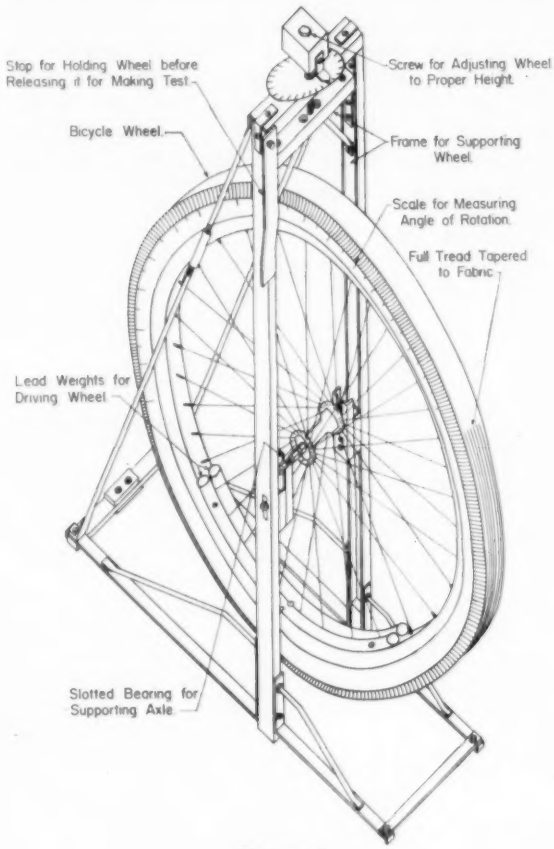
Stop for Holding Wheel before Releasing it for Making Test
Bicycle Wheel
Screw for Adjusting Wheel to Proper Height
Frame for Supporting Wheel
Scale for Measuring Angle of Rotation
Full Tread Tapered to Fabric
Lead Weights for Driving Wheel
Slotted Bearing for Supporting Axle

FIGURE 3

NCSA Wheel for Making Slipperiness Tests
Operation: Apparatus is placed on section to be tested and tire is lowered to point of contact with road surface. Wheel is then rotated bringing lead weight to top position and held fast by stop. Height adjusting screw is given two complete turns to lower wheel. Tire and road surface are thoroughly wetted, then stop is released. Lead weights rotate wheel to a given speed until friction begins to act bringing wheel to rest. The angle turned by the wheel is read on the scale and is a measure of slipperiness.

bicycle whose axle is mounted in vertical slots in the supporting frame. The tire is ground off, practically exposing the tire fabric over half its circumference. The other half of the tire retains its full thickness of tread. Two copper tubes filled with lead are mounted side by side on the tire rim and a scale graduated in spaces of 5 degrees is marked on the side of the tire. Although full details are not shown in the accompanying Figure 3, blue prints giving the details necessary for reproducing the NCSA wheel will be made available upon request.

To measure slipperiness with this device, the tire is rotated to bring the lead weights to their uppermost position and the height of the wheel is adjusted so that the wheel turns freely except when the thick portion of the tire is down on the road. The wheel is released, allowing the weights to rotate it so that the thick portion of the tire strikes the pavement surface; and thereby the wheel is raised slightly and the axle rises in its slotted support. The wheel is then supported only by the road surface and it continues to turn until brought to rest by friction between the tire and the road. The more slippery the pavement, the greater will be the angle of turn required to bring the wheel to rest. Generally an average of 8 readings in a given path is taken to indicate the pavement slipperiness. The readings in three different wheel paths are averaged and excellent accuracy is obtained quickly with this simple, inexpensive, and perhaps unscientific appearing device. The whole operation of setting up, adjusting, and reading requires an average of 20 seconds per reading.

Correlation of NCSA Wheel With Stopping Distance Tests

At the present time several types of machines are used in the field to determine the slipperiness of pavements and they give different values for coefficient of friction on identical surfaces. Stopping distance tests are made in which an automobile is stopped from a given initial speed, generally 40 miles per hour, by locking the wheels, and the distance required to bring it to rest is determined. For constant conditions in the test vehicle, this test is fairly reliable and most nearly approaches impending crash conditions. However, appreciable variations in test results can occur, depending on tire equipment, the design characteristics of the test automobile, and other variables.

On several occasions pavement surfaces have been tested with the NCSA wheel and also with stopping distance tests. As a result, Table II is given as representing the correlation between the NCSA wheel measurements vs stopping distance tests made with particular test vehicles equipped with their "regular" tires. Other tires and other tire conditions could alter this table somewhat.

TABLE II

Relationship Between NCSA Wheel Tests and Stopping Distance Tests at 40 Miles per Hour[1]

NCSA Wheel degrees	Stopping Distance Tests 40 mph "Regular Tires"
41	f = .63
48	.50
69	.40
83	.27

[1] Table based on cooperative tests made at the First International Skid Prevention Conference, Charlottesville, Virginia, September 1958

An NCSA wheel angle value of 69 degrees is approximately equivalent to a coefficient of friction of 0.4 if "regular" tires are used on the stopping distance test vehicle. Other tires on the stopping distance vehicle may give different results for coefficient of friction (f), perhaps 0.06 to 0.07 higher than with regular tires. Tires have a significant effect on stopping distance. This is important because a requirement for pavement slipperiness of f = 0.4 at 40 mph used by some agencies is most likely based on "regular" tires stopping distance tests, since this requirement was not established recently. Tires are being improved and are safer against skidding than those of several years ago.

The indications are, therefore, that if a pavement surface shows a value of 69 degrees or less in the NCSA wheel test, it will have a coefficient of friction of at least 0.4 in the stopping distance test at 40 mph. This value is considered satisfactory and should be used until a more permanent criterion is established.

Other tires on the stopping distance test vehicle have been known to raise the coefficient of friction at 40 mph up to about 0.47 instead of 0.40. This is a big difference in the value of *f*. It furnishes an additional safety factor which cannot be ignored.

Establishment of Permanent Standards of Slipperiness

It seems quite necessary that there be established a reliable set of standard test surfaces to be used as practically unchanging standards of slipperiness. Such standards are necessary because the tires used on the various slipperiness testing machines, including stopping distance, towed trailer, and including also our NCSA wheel, can and do change from time to time from various causes, including wear, temperature, and different rubber or tread characteristics. Also other variables in field apparatus evidently exist.

At the present time in the NCSA Laboratory we are using as standards of slipperiness plate glass plates (3 in. by 4 in.) whose surfaces have been ground with carborundum of different degrees of coarseness.

Such standards, because of their small size, cannot be compared directly with the large field testing machines. However, the NCSA wheel can be calibrated with these plate glass standards and it can also be used on field test sections as well as in the laboratory. Thus a means is offered of calibrating any field machine and any pavement surface with the permanent standards of roughness which already have been used by NCSA but which should be more perfectly established on a permanent basis.

It may also be possible to use special test pavements built for calibration purposes. These test pavements could be finished to several degrees of smoothness but they should not be used for any other purpose. Even these pavement sections, however, should be compared with a constant unvarying standard such as above described, for pavement test surfaces may not remain in a sufficiently constant condition due to weathering and marring by the test vehicle.

Adequately Non-Skid Pavement Surfaces

A commonly accepted cause of a pavement's slipperiness is the polishing of its surface in varying degrees under the action of traffic. Some roads constructed entirely of limestone aggregate, both fine and coarse, have been found to be excessively slippery while, on the other hand, there are localities where limestone has been used for years and the roads have not become slippery. It would, therefore, appear that something should be done to assure the building of road surfaces possessing adequate skid resistance. Also, it should be apparent that the rejection of stone because its name is "limestone" is not a valid solution of the slipperiness problem. Even very hard stones will in time polish under the action of heavy traffic.

Pavement slipperiness has been studied in the Laboratory of the National Crushed Stone Association for the past 6 years and, as a result, a reliable method of test has been developed for solving the slipperiness problem. Since the apparatus and test procedure are described above, a discussion of the methods used to improve skid resistance and some test results, with their indications, will follow.

There is little doubt that the skid resistance of concrete and of asphalt paving mixtures, if slippery, can be improved. However, the major question is to what degree or level is this feasible? Heretofore, whenever the problem of a slippery pavement arose, the immediate and sure solution has been to resurface with Kentucky Rock asphalt or with a sand-asphalt mix similar to Kentucky Rock. Kentucky Rock asphalt probably possesses the highest resistance to skidding of any commonly used paving material. It has been regarded as having that standard of performance which should be attained, but this is an unsatisfactory approach toward an invariable and final solution to this problem because the implication is that all surfaces must have the highest attainable skid resistance. A more reasonable approach must be sought through the establishment of a surface having an adequately safe skid resistance rather than the highest possible resistance. Let us not forget that our specifications for practically all structural and highway materials are aimed at obtaining materials that will be adequate for the job. We do not specify the very best and thereby exclude materials that are satisfactory.

The First International Skid Prevention Conference restated the idea that different levels of skid resistance should, within reason, be used on our highways. Highly skid resistant surfaces should exist at the approach to critical intersections, stop lights or stop signs, on steep grades, and on sharp curves. However, a recommendation of a coefficient of friction which would offer

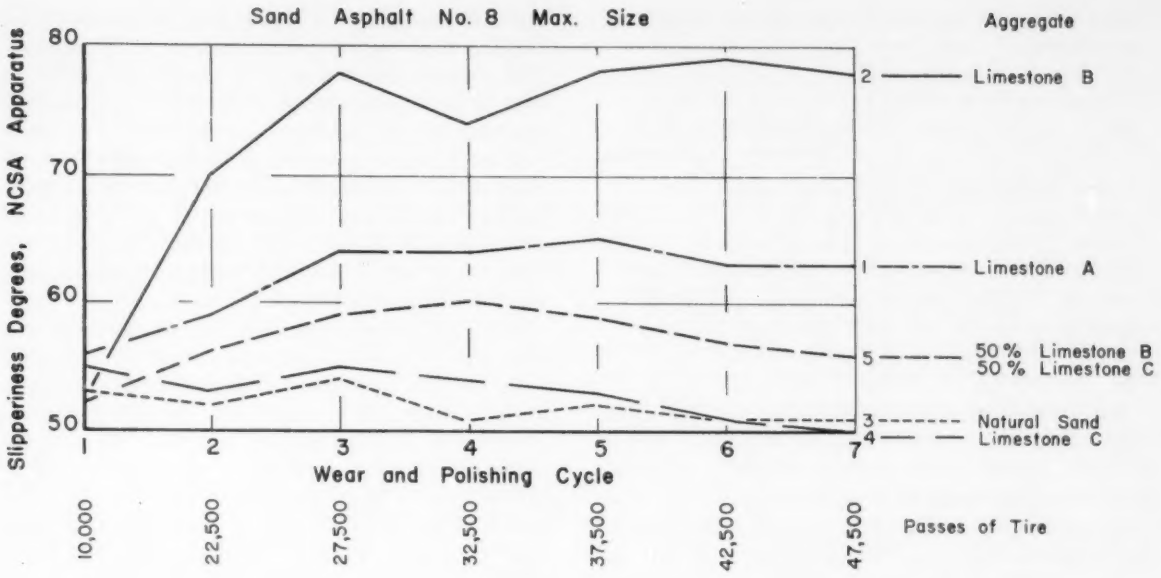

FIGURE 4
Series I—NCSA Wheel Tests for Slipperiness of Sand Asphalt Mixes

adequate skid resistance was not made, but the suggestion was made that a proper level of adequacy should be established. A value of 0.4 at 40 mph, stopping distance test, would seem to offer adequate skid resistance bearing in mind that the AASHO curve for coefficient of friction values for calculating stopping sight distances shows a value at 40 mph of 0.325.[1]

With this coefficient of friction of 0.4 as an indication of adequate skid resistance an illustration will be given showing the results of a laboratory investigation to improve the skid resistance of an asphalt paving mix.

Series I—Laboratory Study for Improving Skid Resistance of Asphaltic Concrete

A comparison study of the NCSA skid measuring apparatus with stopping distance measurements gave indications that a wheel angle of 69 degrees in the NCSA wheel apparatus approximates a coefficient of friction of 0.4 in the field stopping distance test at 40 mph. It, therefore, would seem reasonable to assume that any surface which was exposed to the polishing action of traffic and which after continued polishing *maintained* a skid resistance of 69 degrees or less would be adequate.

The problem in the present tests, Series I, involved three limestones and a natural sand. These aggregates were local to a given area and may be briefly described as follows:

Limestone A—a dolomitic limestone with approximately 6 per cent insoluble residue

Limestone B—a high calcium limestone of metallurgical grade with about 4 per cent insoluble residue

Limestone C—an impure limestone with about 20 per cent insoluble residue

Natural sand—essentially a calcareous sand with approximately 35 per cent siliceous material

The problem resolved itself into a determination of the maximum amount of limestone A that might be used in a surfacing mix which would have adequate skid resistance. Ten mixes were placed in the circular track: 5 were asphaltic concrete with 3/8 in. maximum size aggregate and 5 were sand asphalt with No. 8 maximum size aggregate. The gradation and asphalt content

[1] "A Policy on Geometric Highway Design of Rural Highways," 1954, p. 436, American Association of State Highway Officials, National Press Bldg., Washington, D. C.

were the same for each type of mix and were as follows:

Type of Mix	3/8 in. Asphalt Concrete	No. 4 Sand Asphalt
Gradation of Aggregate		
Total per cent passing		
1/2 in.	100	
3/8 in.	98	
No. 4	64	100
8	47	86
50	7	18
200	2	7
Asphalt Content	6.0	8.0

Sand asphalt mixes using each of the four aggregates and a 50-50 blend of limestones B and C were placed in the circular track, compacted, and subjected to cycles of wear and polishing, and skid resistance measurements were taken at the end of each cycle. The results are shown in Figure 4, which are significant in two respects. First, the curves give definite indications that an end point has been reached in the polishing of the surface which means that the skid resistance of some of these surfaces is not only adequate but can be expected to remain in a satisfactory condition indefinitely.

The other significant result is the marked difference in the skid resistance of limestones. Limestone B polishes easily and quickly, thereby soon developing a surface that is excessively slippery. The impure limestone C is quite non-skid. In fact, it is as good as the mix containing natural sand having 35 per cent insoluble residue. Figure 4 is particularly interesting in showing the great improvement in skid resistance that can be made by the blending of aggregates (50 per cent limestone B and 50 per cent limestone C). If the limit of slipperiness were defined, adequate mixtures could be readily ascertained.

The other study, Figure 5, had for its objective the improvement of skid resistance by changing only the fine aggregate in asphalt concrete made with limestone A as the coarse aggregate. Limestone A developed a slippery surface. When limestone B was used as the fine aggregate portion, the mix soon became excessively slippery. The use of either natural sand or limestone C as fine aggregate gave mixes of adequate skid resistance. A 50-50 blend of fine aggregates, limestones A and C, would provide a surface of moderate skid resistance.

With these data at hand, the solution of the problem is now easy, if all factors are rightfully considered. The use of natural sand-asphalt has been considered by some to be the solution. These data clearly show, however, that limestone C is as good as this particular natural sand.

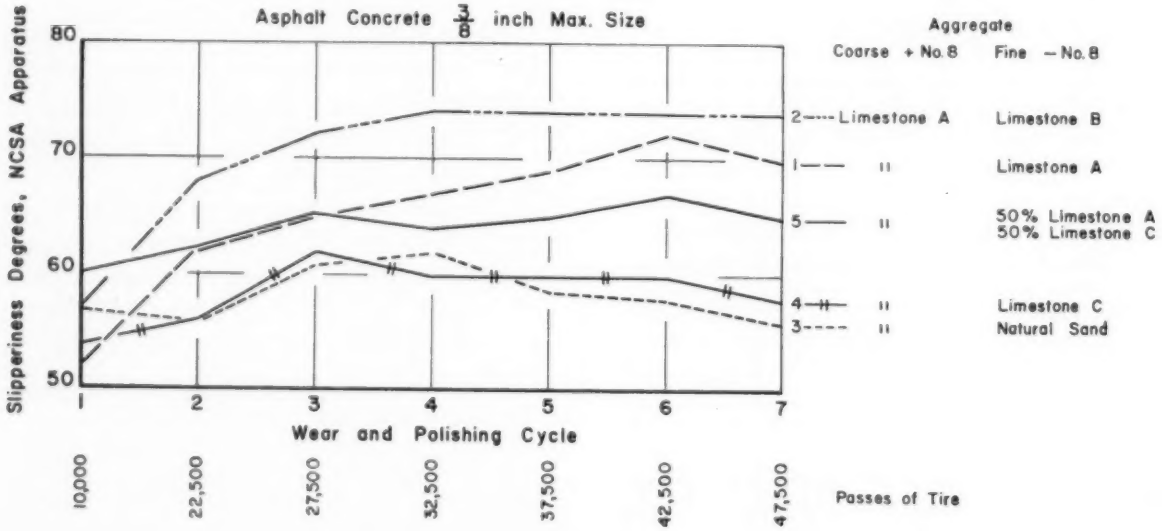

FIGURE 5
Series I—NCSA Wheel Tests for Slipperiness of Asphaltic Concrete Surfaces

The foregoing study involving particular aggregates is believed to be a realistic and sound approach to the solution of the problem of producing skid resistant road surfaces. It deserves thoughtful consideration on the part of highway and materials engineers.

Those familiar with the skidding problem believe that road surfaces should be built having permanent non-skid properties. In some localities having preponderantly aggregates which become slippery under traffic and a scarcity of non-polishing materials, an excellent cure for slippery surfaces seems to be the use of a thin cover of a special sand-asphalt mix. Whether this, over a term of years, will be the most economical cure has not been ascertained, for the question of durability and that of stability have not been answered because of the short duration of their use. Up to the present this method of skid proofing has seemed satisfactory.

It is believed, however, that other solutions to the problem of skidding are available which will be adequate and which may prove in the long run to be most economical and most satisfactory. With some aggregates, changes in the proportions of the surface mixture are needed, including the substitution of a skid resistant material for the fine aggregate portion of the slippery aggregate. Experiments with this method for remedying slippery mixtures are described in Series II which follows.

Series II—Laboratory Study for Improving Skid Resistance of Asphaltic Concrete

In still another project, studies were made for slipperiness of asphaltic concrete and sand-asphalt surfaces, for the purpose of determining how best to improve the skid characteristics of mixes involving a particular limestone. The testing procedure was as previously described. The circular track was used to prepare and polish the test specimens to their ultimate degree of polish and the NCSA wheel was used to determine their slipperiness.

The aggregates included a limestone which was said to produce a slippery asphaltic concrete pavement, a granite, a slag, and a natural siliceous sand. These materials were graded as in Table III.

Preliminary asphaltic mixes were made for determining approximately the optimum asphalt content prior to laying the test track.

The sections were mixed in a laboratory pug mill, rolled to compact them and, finally, after all sections had been placed, they were given the following treatment:

Cycle	Treatment
1—Compaction	10,000 passes of bus tire loaded to rated capacity of 55 psi, on clean dry surface at elevated temperature (100° F)
2—Wear	2,000 passes of loaded tire pulling a weighted rubber drag. Track surface damp and covered with minus 50 mesh siliceous sand, followed by 1,200 passes of tire only with track damp and covered with minus 50 mesh siliceous sand.
Polish	1,300 passes of loaded tire on clean dry surface
3—Polish	5,000 passes of loaded tire on clean dry surface
4—Polish	5,000 passes of loaded tire on clean dry surface
5—Polish	5,000 passes of loaded tire on clean dry surface
6—Polish	5,000 passes of loaded tire on clean dry surface

After each polishing cycle, tests for slipperiness were made with the NCSA wheel test in three paths, making 8 readings in each path. The average of twenty-four readings gave the results in Table IV.

TABLE III

GRADATION OF AGGREGATES

Lab No. Nominal Maximum Size Identification	Blend 1/2 in. Limestone	5728 1/2 in. Granite	5738 1/2 in. Slag	5724 3/8 in. Limestone	5726 Screenings Limestone	5727 Screenings Granite	5730 Screenings Slag	5734 Natural Sand	Limestone Mineral Filler
Total per cent passing									
3/4 in.	100	100	100						
1/2 in.	95	95	98	100				100	
3/8 in.	56	53	55	99	100	100	100	99	
No. 4	10	5	3	15	97	94	75	94	
8	2	4	1	1	71	83	48	79	
16	1	3	1	1	42	68	30	51	
30	1	2	0	1	29	53	20	34	100
50	1	1	0	1	21	35	12	20	99
100	1	1	0	1	16	19	6	9	99
200	1	1	0	1	14	10	4	3	95

TABLE IV

SLIPPERINESS TEST ON EIGHTEEN ASPHALTIC MIXTURES
ALL SUBJECTED TO IDENTICAL POLISHING TREATMENT

Mix Proportions by Weight, Slipperiness Readings After Sixth Cycle

Section No.	Coarse Aggregate per cent	Fine Aggregate per cent	Mineral Filler per cent	Asphalt per cent	Average Slipperiness degrees
1	1/2 in. LS 42.4	LS Scr. 44.1 Nat. Sand 7.8		5.75	69.2
2	1/2 in. Granite 51.7	Granite Scr. 42.3		6.0	56.4
3	1/2 in. Slag 36.3	Slag Scr. 50.8	3.6	9.25	59.0
4	1/2 in. LS 42.4	LS Scr. 33.7 Nat. Sand 18.1		5.75	63.5
5	1/2 in. LS 41.3	LS Scr. 17.6 Nat. Sand 32.9	1.9	6.25	61.2
6	1/2 in. LS 42.2	Nat. Sand 47.8	3.7	6.3	60.8
7	1/2 in. LS 42.2	LS Scr. 33.6 Slag Scr. 18.0		6.25	69.0
8	1/2 in. LS 41.9	LS Scr. 17.2 Slag Scr. 32.1	1.9	6.9	65.0
9	1/2 in. LS 44.4	Slag Scr. 44.4	3.7	7.5	67.1
10	1/2 in. LS 27.7 1/2 in. Slag 18.5	LS Scr. 24.1 Slag Scr. 22.2		7.5	63.1
11	1/2 in. LS 23.6 1/2 in. Granite 23.6	LS Scr. 23.6 Granite Scr. 23.5		5.7	58.0
12	1/2 in. LS 23.4 1/2 in. Granite 23.4	LS Scr. 23.5 Nat. Sand 23.5		6.25	60.3
13	3/8 in. LS 37.6	LS Scr. 56.4		6.0	73.6
14	3/8 in. LS 32.8	LS Scr. 39.4 Nat. Sand 21.5		6.3	64.3
15	3/8 in. LS 32.7	LS Scr. 20.6 Nat. Sand 37.4	2.8	6.5	59.7
16	3/8 in. LS 39.1	Nat. Sand 49.7	4.7	6.5	58.8
17	3/8 in. LS 46.9	Granite Sc. 46.9		6.25	63.7
18	3/8 in. LS 27.3	Slag Scr. 59.6	4.6	8.5	64.3

The most slippery sections, beginning with the most slippery, are as follows:

Section No.			Average Slipperiness degrees
13	3/8 in.	limestone, limestone screenings	73.6
1	1/2 in.	limestone, limestone screenings 44.1 per cent natural sand 7.8 per cent	69.2
7	1/2 in.	limestone, limestone screenings 33.6 per cent slag screenings 18.0 per cent	69.0
9	1/2 in.	limestone, slag screenings 44.4 per cent	67.1
8	1/2 in.	limestone, limestone screenings 17.2 per cent slag screenings 32.1 per cent	65.0

The seven least slippery sections, beginning with the least slippery are:

Section No.			Average Slipperiness degrees
2	1/2 in.	granite 51.7 per cent granite screenings 42.3 per cent	56.4
11	1/2 in.	limestone 23.6 per cent limestone screenings 23.6 per cent	
	1/2 in	granite 23.6 per cent granite screenings 23.5 per cent	58.0
16	3/8 in.	limestone 39.1 per cent natural sand 49.7 per cent	58.8
3	1/2 in.	slag 36.3 per cent slag screenings 50.8 per cent	59.0
15	3/8 in.	limestone 32.7 per cent limestone screenings 20.6 per cent natural sand 37.4 per cent	59.7
12	1/2 in.	limestone 23.4 per cent limestone screenings 23.5 per cent	
	1/2 in	granite 23.4 per cent natural sand 23.5 per cent	60.3
6	1/2 in.	limestone 42.2 per cent natural sand 47.8 per cent	60.8

Judging from the tests, the following conclusions from this Series II tests may be drawn:

1. The all limestone mix is most slippery and this agrees with the opinion of the State Highway Department.
2. All granite and all slag mixes have a satisfactory degree of skid resistance.
3. The limestone mixes are made to compare favorably with the all granite mix (No. 2) by the use of admixtures of granite, coarse and fine (No. 11), and by natural sand substitution (No. 16), and are somewhat better than the all slag mix (No. 3).

A study of Table IV will show other characteristics which need not be discussed here.

However, again it is demonstrated that if any aggregate such as limestone, when used as the total aggregate in an asphaltic concrete mix, has produced a slippery pavement, the cure need not be that of utterly rejecting the limestone, but rather steps should be taken to substitute a less slippery aggregate for a portion of the limestone in the pavement surface course only. In this case, a mix of 50 per cent silica sand and 50 per cent limestone (Section 6) or a mix of 50 per cent granite and 50 per cent limestone, both coarse and fine (Section 11) gave adequate surface as did also Section 12 of limestone and granite coarse aggregate and limestone and natural sand fine aggregate. A thin sand-asphalt treatment as used in Virginia is also very effective as shown by our past tests.

The building of highways in the new national program and in the years to come will require tremendous tonnages of stone. Aggregates need not be discarded for they can be saved for use by proper blending with other available materials. The discarding of aggregates would inevitably have the effect of decreasing the aggregate supply at a time of increasing demand. We believe this to be unnecessarily wasteful of aggregates which can be used with satisfaction.

Resume of Important Conclusions

1. Reducing the speed of vehicles from 60 to 50 mph is more effective as a safety measure than increasing the coefficient of friction from 0.4 to 0.6 and maintaining the speed at 60 mph.

2. It is folly to maintain high speeds in wet weather, no matter what may be the road surface. Wet weather restrictions on all roads are needed.

3. The coefficient of friction in a locked wheel stop from 40 mph may be determined in the laboratory by using the NCSA test method. A coefficient of friction of 0.4 is equivalent to an angle of 69 degrees in the NCSA wheel test.

4. Because tires on field skid test machines change due to rubber composition, tread pattern, and other variables, it would be desirable to calibrate all field equipment in terms of permanent, durable, standards of pavement slipperiness. These could take the physical form of 3 in. by 4 in. glass plates having surfaces ground with carborundum of different degrees of fineness. Using the NCSA wheel or other small testing device suitable for both laboratory or field use the field machine readings can be expressed in terms of small permanent standards of slipperiness such as prepared glass plates. The ultimate description of road slipperiness should be in terms of these permanent standards.

5. If certain aggregates when used alone in an asphaltic concrete mix produce slippery pavements, the substitution of non-slippery fine aggregate for the slippery fines will effectively reduce the tendency of the resulting mix to become slippery.

6. The cure of slipperiness in pavements need not involve the total rejection of the slippery aggregate from use, but rather a substitution of a non-skid aggregate for a portion of the slippery aggregate.

7. Approximately 72 per cent of the 536 million tons of stone produced for all purposes in the United States in 1957 was limestone. Full production is needed for future highway construction and hence every effort should be made to use it as fully as possible commensurate with satisfactory results.

8. Fortunately, the discarding of aggregates is not required to solve the slipperiness problem.

Acknowledgment is made of the able assistance of our Testing Engineer, J. E. Bell, and his laboratory assistants in obtaining and analyzing the test results in these investigations.

Where is the Money Coming From to Meet Highway Needs?[1]

By PYKE JOHNSON

Past President
Automotive Safety Foundation
Washington, D. C.

PERSPECTIVE is needed to a full understanding of why the chief problem which faces the federal highway program today is money. Moreover, some background discussion is desirable to disclose the essentially non-partisan attitude which Congress has always taken in highway matters.

In 1955 the Congress had before it the recommendations of the Clay Commission. These were: That the Congress should enact a program involving the construction of 40,000 miles of interstate highways in ten years time with three years of grace for its completion. To pay for it, they recommended a bond issue which should be amortized in 33 years time based on existing gas taxes. Linked with this was a proposal for the creation of a federal highway corporation as the administrative agency.

The committees accepted the central idea of the necessity for building the roads, but threw out both the bonding idea and the federal highway corporation; the first because the idea of heavy interest charges was not acceptable; the second because of a general dislike for the idea of creating any new independent agencies.

The Congress itself over-turned the total idea because the tax increases resulting from a turn to a pay-as-you-go program were held to be inequitable.

In 1956, the Congress extended the construction program to 13 years, put the financing schedule on a 17 year basis, and modified the tax structure. The bill was then passed almost unanimously with the addition of a Federal Trust Fund which was set up as a depository for all those motor vehicle taxes which the Act dedicated to highway purposes.

In setting up this Fund, itself a major change in federal highway fiscal policies which up to that time had drawn funds from the general fund of the Treasury, an important last minute change was made.

That change, popularly known as the Byrd Amendment, but having back of it the support of the Treasury, required that all apportionments in any given year for the Interstate System should be limited to the funds which the Secretary of the Treasury estimated would be available in the Trust Fund to liquidate contracts arising from such apportionments.

In other words, although the financing provisions of both the Clay Committee and the 1956 Act gave clear evidence that there would be years when existing funds would be inadequate, the federal program was to be on a strictly pay-as-you-go basis.

This change made no difference in the opening years of the program since while some construction began at once on the new system, the time lag in payments was such as to make existing funds adequate.

The first evidence of a growing pinch in the program came last year when the Congress had to make a decision to reduce the program; to add new taxes; or to suspend the Byrd Amendment.

On the recommendation of the Administration, they took the latter course. Since the bill as drafted prior to the Byrd Amendment contained in it a provision authorizing appropriation of funds from the general treasury to be paid back at a later date, plus interest, the congressional action ended there. No new taxes were added.

However, the suspension was limited to the apportionments for fiscal years 1959 and 1960.

[1] Presented at the Washington Section, Institute of Traffic Engineers, Shoreham Hotel, Washington, D. C., January 6, 1959

Upswing in Cost

Meanwhile, another series of events had a direct bearing on the cost of the program. The estimates submitted by the states in 1958 took cognizance of these facts:

1. An increase of 12 per cent in the general costs of highway work, due to mounting costs in all parts of the economy.

2. An increase in traffic volume of 5 per cent over and beyond earlier estimates.

3. An increase of 3 per cent caused by that section of the act which required reimbursement to utilities on the basis of existing state laws.

4. An increase of 15 per cent due to the change in the local section of the Act which required consideration of local traffic needs where "practicable, suitable, and justifiable."

It should be further noted that included in the total costs of the Interstate program but not contained in the 1958 estimates is the 1,500 miles needed to bring the total mileage to 40,000 miles which had not been designated when these estimates were made. The cost of these roads is estimated at around $1.5 billion.

So the total federal costs of the interstate program now come to some $34 billion as against the original $25 billion, or around a 37 per cent increase. Parenthetically, while the Congress added still another 1,000 miles to the 40,000 mile system, it specifically stated that funds were not to be provided for those added roads under the terms of this legislation.

Further as an aside, it increased the ABC funds by $25 million and added an emergency work program of $400 million.

Under the 1958 legislation, the Secretary of Commerce went ahead with apportionments for 1960 based on the annual authorizations contained in the Act of 1958. But that is as far as he can go under existing law.

Meanwhile, the construction program has been steadily mounting. The reports of Federal Administrator Tallamy consistently show that the full program of work for both the ABC and Interstate systems has been right on schedule.

The effect has been an increasing withdrawal of funds from the Federal Treasury with the net result that the balance on November 1 was only $811 million. Since expenditures will exceed revenues during 1959 and 1960, it will be necessary under present legislation to draw upon the general funds of the treasury. The law made repayment of these amounts, plus interest, a first call in determining amounts of Interstate funds that may be apportioned for 1961 and subsequent fiscal years.

In cold fact, what this means is that unless the Congress acts at this session, there will be no funds available for interstate apportionment in 1961 and estimated amounts for that purpose in 1962 will approximate $300 million.

Congressional Action Now

In other words, failing congressional action now, all those industries dependent upon the interstate program will find their market gone in 1961 and not fully restored for many years to the level pledged by Congress in 1956.

Too much emphasis cannot be placed upon the immediate and emergent impact upon the national defense, the general economy as well as upon the related industries and, most immediate of all, upon the safety of users of roads if this situation is not met.

Without attempting to go into detail, approximately $4 billion more will be required to provide: (a) for repayment of funds borrowed from the general treasury for work authorized in prior years; and (b) for apportionment of funds already authorized by Congress for the fiscal years 1961 and 1962.

The equally essential ABC program does not now appear to be affected as it has first call on all construction funds in the Trust Fund.

In the public discussions which have taken place up to the present time, there is no evidence that responsible public officials anywhere have any desire to "stretch out" the program.

On the contrary, Senators Gore and Case, as the ranking heads of the Democratic majority and the Republican minority in the Senate, and Congressmen Fallon and Scherer as their opposite numbers in the House, have stated flatly that the program must go forward.

Organized groups of industrial leaders generally, the National Grange, the car and truck user groups, and public officials at all levels of government have supported this position.

Alternate Financing Methods

The problem then comes down, as it usually does, to where the money is to be found to do the job. Here there are sharp differences of opinion since quite generally the accepted way of getting things done is to make the other fellow pay for it, if possible.

Up to the present time, the alternative courses appear to be very w.

Increase in Gas Tax

1. The President has been quoted as favoring an increase of 1 and 1/2 cents per gallon in the existing federal taxes of three cents a gallon. This would be sufficient to do the job in present day terms of cost. The reasons cited for this position are generally known. They are keyed to his desire to prevent inflation by balancing the budget.

Against this point of view there has been a widespread and what appears to be an almost unanimous group opposition to any further highway tax increases at this time. The volume of this protest might be discounted somewhat if it came alone from immediately affected private groups, but there are other elements of serious concern to be considered.

(a) The Congress itself in passing the Highway Act was not sure that the taxes as now levied would prove to be equitable. So it directed the U. S. Bureau of Public Roads to make a broad inquiry into the whole highway tax program and to come back in 1960 with recommendations as to what would constitute a fair and equitable tax base. The task has proved a monumental one and the Congress has now extended the life of that inquiry until 1961.

Clearly, any action taken by Congress now would at least partially foreclose judgments which will be forthcoming next year; might irrevocably close the door to a possible better course of action.

(b) Few people fully understand even yet, all the implications of the federal highway law, particularly its limitations. The fact is that under the existing law, the Federal Government shares only in the cost of construction of less than 25 per cent of the total road and street mileage of the United States. True, these generally are the most important roads in volume of traffic but that is true only generally. The constant up-surge of traffic is forcing the development of a large mileage of roads to interstate standards which lie completely outside the pale of the federal law. Look at any major city in the United States and it will be seen at once that all of them require now many, many miles of streets far beyond existing standards. Yet these roads may be solely the responsibility of states and their sub-divisions.

Remember, too, that all maintenance costs of all roads are paid for by state and local taxes, except for the small mileages of housekeeping roads within federal lands.

Even before that, there are some 13 states in the country today, and there will be many others added in the near future, which are finding need for additional funds to carry on their relations with the Federal Government.

New York State is only one instant example of this total situation. Virginia is another. Hard-pressed public officials in these and other jurisdictions are already planning to recommend increases to their legislatures this year. Their path will be made much more difficult if at the same time, the Federal Government should "up" the gas or other motor vehicle taxes, which traditionally at the state level have gone to highway purposes.

Earmarking for Trust Fund

2. A second suggestion which would not require any increase in motor vehicle taxes at this time, is that the Federal Government should ear-mark those remaining motor vehicle taxes which it now collects, for the Highway Trust Fund. The amount of these would be sufficient to meet the needed funds. Another way of saying what amounts to the same thing, is that the money should come from the general fund.

On this point, Senator Case, speaking at the San Francisco meeting of the AASHO, said that should this course be taken, he was convinced it would meet with a presidential veto.

The reasons are clear. Motor vehicle taxes would not increase but their withdrawal would have to be met by the application of new taxes in some other field. Realistically, there are few who believe that in a Lunik age the existing federal budget can be trimmed in any substantial way.

Short Term Bonds

3. The third course that presents itself is one that both the Congress and the administration have already subscribed to: the Congress implicitly, by its passage of the existing legislation permitting borrowing from the general fund with repayment later; the President, by his endorsement of the original Clay Bill.

This could be either a complete turn to bonding for the financing of the entire program from this time forward which no one seems to be seriously considering; or to an interim operation which thus far appears to have considerable public support. (It should be noted, however, that so far as the speaker knows, no member of the responsible Ways and Means Committee of the House or the Finance Committee of the Senate has yet had anything to say publicly on this or other aspects of the financing problem. Yet it is those bodies which must make these decisions.)

The argument in support of this position may be summed up in this way:

The Congress has already created a precedent by suspending the Byrd Amendment for the first years of the program. Suppose it takes a similar interim action now. The Treasury could then be authorized to issue short term serial revenue bonds or certificates of indebtedness in the name of the Highway Trust Fund as and when required up to a total of $4 billion. As a surety for such obligations, it could then extend the life of existing trust fund taxes from 1972 to such period as it might deem necessary to protect investors.

Under such a procedure, the program could go forward in 1961 and 1962 as pledged by Congress itself; the Bureau study could be completed as a basis for future policies; and the states would not be hindered by further invasion of a field which has been peculiarly theirs except for emergencies until enactment of the 1956 Act. Such action would not increase the debt ceiling.

Against this it can well be argued that bonds cost money and that it is wiser to face the music now than it is to delay the issue. It will cost less to do it on a pay-as-you-go basis. In any event, it should be clearly understood that more funds than are presently authorized will be required later if there is to be no stretch out.

Highway Program Must Move Ahead

Aside from the emergence of some magician who could provide the cash without running afoul of the FBI; or a cessation of cold war which appears equally impractical at this point, the speaker knows of no other course of action which has yet been suggested that would pass the practical test of congressional action.

One thing remains clear, however. The people of the United States are insistent upon getting forward with the road program. They know what it means to be fouled up in traffic congestion. They know the hazards of rural driving on inadequate roads. They know that one way or another they must pay for roads whether they get them or not.

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Explosives Division

East Alton, Ill.

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Pennsylvania Crusher Division
Bath Iron Works Corp.

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Pettibone Mulliken Corp.

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Pioneer Engineering
Division of Poor & Co.

3200 Como Ave., Minneapolis 14, Minn.

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Pit and Quarry Publications, Inc.

431 South Dearborn St., Chicago 5, Ill.

Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Modern Concrete, Concrete Industries Yearbook, Equipment Distributor's Digest

Manufacturers Division – National Crushed Stone Association
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Thermoid Division

Tacony and Comly Sts., Philadelphia 24, Pa.

Conveyor Belts, Hose, and Packings

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Reich Bros. Mfg. Co., Inc.

1439 Ash St., Terre Haute, Ind.

Rotary and "Down-the-Hole" Drilling Machines for Exploration, Coring, Blast Holes

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Publications: Rock Products and Concrete Products

Rogers Iron Works Co.

11th & Pearl Sts., Joplin, Mo.

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Schramm, Inc.

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Simplicity Engineering Co.

Durand, Mich.

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SKF Industries, Inc.

P. O. Box 6731, Philadelphia 32, Pa.

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532 East Capitol Drive, Milwaukee 12, Wis.

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Soiltest, Inc.

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Stedman Foundry & Machine Co., Inc.

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East 28th St. and Fulton Rd., Lorain, Ohio

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Torrington Co.
Bantam Bearings Division

3702 West Sample St., South Bend 21, Ind.

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Tractomotive Corp.

County Line Road, Deerfield, Ill.

Rubber Tired Front-End Loaders (Tracto-Loaders)

Traylor Engineering & Mfg. Co.

Allentown, Pa.

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Trojan Powder Co.

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Tyler, W. S., Co.

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Universal Engineering Corp.
Subsidiary of Pettibone Mulliken Corp.

625 C Ave., N. W., Cedar Rapids, Iowa

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Vibration Measurement Engineers, Inc.

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Autocar Division

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No. 4. "Retreading" Our Highways

No. 5. Reprint of "Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey" with Discussion

No. 7. Investigations in the Proportioning of Concrete for Highways

No. 9. Tests for the Traffic Durability of Bituminous Pavements

No. 11. A Method of Proportioning Concrete for Strength, Workability, and Durability. (Revised November 1953)

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